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ABSTRACT

Described is a course development project in progress at Iowa State University, Ames, Iowa, that attempts to meet the individual needs and improve the attitudes of students in a large freshman biology course. Proposed is the implementation of the Phase Achievement System which involves the development of multi-concept level video-cassette lectures available for library use, a computer-based data processing system designed to score examinations and keep student records and to generate master copies of the examinations from an existing 2,500 entry multiple choice question pool. In its entirety, the plan allows for self-pacing of both instruction and testing; a flow chart of the alternative pathways open to students illustrates the flexibility of the Phase Achievement System. (CS)

A COORDINATED PROGRAM
for
Providing for Individual Students
In Large Lecture Sections *

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ABSTRACT

A unique combination of mastery learning with the instructional alternatives of live lecture or multiple level video cassette lectures available on demand is being developed for the freshman year of lecture courses in biology at Iowa State University. Previous work indicated that mastery learning can meet the needs of individual students, especially high anxiety female students, and that many students appreciate the freedom from absolute schedules that such a system permits. The investigators will use mastery learning in three core lecture courses for the major and non-major as an alternative to concurrent traditional class lectures with regular exam schedules. To be most effective, however, traditional and mastery strategies must include several instructional alternatives. Video cassette lectures are being made to maximaze the instructional alternatives available to the student. Videotapes of course lectures are being produced at the average, remedial, and advanced levels. This will allow students to work at their own pace, which might be faster or slower than a live lecture progression. Videotape presentations will include verbal lectures, demonstrations, and graphics. All video cassettes and associated playback equipment will be housed in the I.S.U. Library to provide ready student access. Upon completion of the videotapes (1978), an experiment in individual course design will be performed. With established guidelines and under an examination contract, students will be able to select from the tape bank a set of lectures to constitute an individualized course.

The development, use, and benefit of this entire program will be evaluated by a team of educators, psychologists, and biologists. A sequential evaluation design in which the instructional and testing options available to the student will gradually increase over three years will be used. As each option is added, performance, background, personality, and attitude data on each student in representative samples will be collected. Data will be analyzed by a path analysis model which will allow an understanding of the interaction of the variables in determining achievement and attitude. Counseling recommendations on alternatives for subsequent students will be based on this predictive model. The results of this study should be of use to all educators contemplating similar changes in instructional formats.

Introduction Virtually all universities use large lecture instruction at the first year level. Administrators have encouraged this application of the mass lecture format to increase efficiency. At the instructional level, this mode of teaching centers around the concept of the hypothetical average student who follows a rigid time schedule. Individual academic growth is assumed to occur in this situation, and little consideration is given to student differences in background or ability or to variations in personal time demands. This has not been a temporary phenomenon, and all universities need to make special efforts to address the unique problems of students in such classes.

At I.S.U. courses in biology, chemistry, computer science, physics, political science, psychology, sociology, and zoology are taught in lecture sections having over 150 students. Freshman lecture courses in biology and zoology alone have combined annual enrollments of 6000 students. Aside from numbers, there is direct evidence of individual differences. The I.S.U. Student Counseling Service has been collecting statistics on the background of entering students as follows:

	1971	1972	1973	1974	1975
Sample Size	3,129	3,373	3,443	3,440	3,660
	High School Rank (1 top; 100 bottom)				
Mean	19.45	19.54	21.94	23.27	24.27
Standard Deviation	14.80	15.38	24.50	18.26	18.97
	American College Testing Program (1-36; average 20)				
Mean	25.74	25.46	25.30	24.70	24.28
Standard Deviation	3.32	3.51	3.70	4.15	4.19

The continued decrease in the mean score values over the last few years is due to an increase in the number of students who scored 40-60 on HSR and 19-22 on ACT. Past studies indicate that students in this category are unpredictable. Some do well; others do not. Educators consider it more difficult to teach a heterogeneous class, and, if the trend continues, teaching will become increasingly more complex.

Individual differences exist in characteristics other than past performance. Previous studies of I.S.U. Biology courses indicate that negative student attitudes develop in large lecture sections, and large lectures tend to accentuate the effects of debilitating test anxiety. A further consideration is that soon another generation of students who have been involved in open classroom concepts will be attending the university. This will add another demension of heterogeneity to student expectation, ability, and performance.

In seeking a solution to the heterogeneity problem, we believe that changes in instructional strategies coupled with improved communications techniques and modern data processing can meet the needs of individual students without prohibitive expenditures. Specifically, we propose to institute a mastery learning strategy in three, first-year biology courses at I.S.U.. This strategy will be supported by live lectures and multi-concept level video cassette lectures available on demand from the Library.

The modified mastery learning plan has developed and used experimentally for the past four years in several sections of Biology 101 at I.S.U.. The mastery learning plan is called the Phase Achievement System (PAS) and is based on a modular course content outlined in published objectives. PAS is instructionally supported by large lecture sections and an audio-tape library. Examinations are offered repetitively outside of scheduled class time and are computer assembled in a modular format corresponding to the eight course units. Students may take the examination modules in any order or grouping up to five times during the enrollment period. Examinations are scored by units, and students are required to achieve a minimum score on each unit and pass a minimum number of units before receiving a specific grade for the course (Appendix, p.A-1). Students progress through the course as seen in the flow diagram (Appendix, p.A-2). PAS is supported by a computer-based data processing system designed to score examinations and keep student records and to generate master copies of the examinations from an existing 2500 entry multiple choice question pool.

During 1975 this teaching method was evaluated by collecting background, performance, personality, and attitude information about each student and determining which combination of these parameters could accurately predict the grade that a student obtained. In the evaluation, these predictors were determined for students in the experimental PAS method and for students in traditionally (lecture and mid-terms) taught biology. The predictors for each method were then compared. Students enrolled in PAS had positive differences both in performance and attitude compared to traditionally instructed students. Positive performance and attitude strongly correlated with decreased test anxiety and increased study effort for female students enrolled in mastery learning. Ability and background were still important in predicting student success, but study effort was shown to be a compensating factor which was expressed when test anxiety was reduced. In brief, the model mastery learning system that has been operating in Biology 101 shows that it is possible to provide for individual students in the large lecture section by using alternative instructional strategies. The report on this study in now in manuscript form.

Project Objectives. By applying the PAS mastery learning model to the three lecture courses in freshman Biology and creating video cassette instructional materials at varying concept levels, we plan to accomplish multiple goals. Foremost is the establishment of a model instructional strategy at I.S.U. which will improve undergraduate biology instruction for majors and nonmajors in large lectures(N>150) by providing for individual differences. By combining technological advancement with concern for human differences, we expect to create an instructional situation in which students will be drawn out of the passive spectator role fostered by large lectures and into a role in which students, with appropriate counseling, will actively pursue instruction and testing through the entire first year of study. Media lectures are not intended to replace live lectures but rather to maximize student alternatives.

The following procedural and materials objectives outline the project:

1. Complete reassessment of what is taught in the first year of Biology to cull redundancy and assure continuity.
2. Create detailed behavioral objectives for students.
3. Establish question pools that are referenced to the behavioral objectives and which will be used in computer-generated examinations.
4. Develop high quality video cassette instructional material at remedial, average, and advanced concept levels and make them available to the students through the Library.
5. Evaluate instructional materials in items 2, 3, and 4 as they are used by students in courses.
6. Revise instructional materials as necessary according to student or faculty opinion and changing need within the university.
7. Introduce the PAS concept as an instructional alternative for the first year biology sequence.
8. Evaluate different instructional strategies applicable to large enrollment courses and to counsel students as to which alternative best suits their needs.
9. Experiment with allowing students to select and individually design course content.

Attainment of these objectives will allow an assessment of progress in terms of the overall goals. An evaluation team will monitor the improvement in undergraduate science instruction by the methods indicated in Evaluation Plan. As the evaluation data on instructional alternatives is analyzed, other departments and the scientific community will be informed by seminars and publications.

When these objectives are met, the alternative education strategy diagrammed in the Appendix, p.A-3, can operate in any one of the courses. The diagram indicates how PAS would function from a dual instructional base of both live and media lectures. Media could be used by students who were accelerating, needed remedial work, or simply wished to review materials. Media breaks the lockstep of the live lecture but does not necessarily replace it. The student aided in his decisions at check points, decides which route is best for him on a particular topic. This plan allows self-pacing of both

instruction and testing and hence provides many alternatives for the individual. Once the courses are aligned to the PAS plan and the instructional materials created, the courses can function without significant cost increases from that currently incurred to instruct similar numbers of students.

Some students, however, appear to require a defined testing schedule. These students could use the instructional materials but need not follow the PAS testing plan. In this way the project materials can also be used to support traditional as well as the mastery learning taught classes.

Video cassette television can provide an effective support for PAS, if used in the proper way. First, television will be used as an instructional alternative to live lectures, not as a replacement. Secondly, television tapes must be available to students on a demand basis, not on a fixed broadcast basis. Television, however, is not a truly interactive medium, and the level of presentation must be adjusted without introducing mediocrity. This will be handled by having multiple videotapes in the demand system, covering the same topics, but at different concept-presentation levels (advanced, average and remedial). Advanced level tapes will involved campus experts and visiting seminar speakers who might consent to make videotapes. The investigators will contact other projects such as BIO-COTIE for premade tapes when possible and may integrate these tapes into their presentations. The color videotapes will be of variable length (averaging 30 minutes) depending on the topic complexity, and the actual presentations will be variable in format. Some will be ordinary lectures, others primarily graphics and offscreen commentary, and others demonstration and discussion. Some tapes may include time breaks as opportunities for students to analyze or graph experimental data.

Once the videotapes are made, an interesting experimental situation which is similar to the Individually Directed Educational Activities (IDEA) Project of Drs. J. Haynes, and D. Gelinas at the University of Maine will be available. It will be possible, after

proper indexing, to draw lectures out of the videotape bank and design a course according to a student's interests. These lectures might be drawn from any of the three courses originally involved and combined into one individualized course. A contract would then be developed specifying what lectures are to be viewed, which tests are to be taken, and what number of college credits will be given. Computer data processing would be used to assure contract compliance. One new course called Individualized Introductory Biology, could be proposed, with variable credit according to the number of units in the contract. Some rules will be developed to prevent a purely random approach. During the last year of the project, this system will be offered experimentally to a small number of students (>150) and the results evaluated to determine if continued effort on this type of system is practical.

Evaluation Plan. The goals and, hence, the evaluation of this project are multi-level. Outcomes will influence students, faculty, available instructional materials, and classroom space utilization. Some outcomes will be project-specific while others will involve university-wide changes or could have impact on the generic needs of science education.

At the project level, the quality of the behavioral objectives, test questions, and instructional tapes will be determined by questionnaires given to the students. This information will be used to make improvements. Test question quality will be improved by computer test item analysis now in operation at the I.S.U. Test Scoring and Evaluation Center. An external auditor, Dr. Sam Postlethwait, will periodically review materials during site visits and offer constructive advice.

A sequential research and evaluation plan will operate. Under this plan, baseline data will be collected on a teaching strategy in each course and then a specific change made and similar data collected. During the three years of the project the options available to students will gradually be increased. During Quarter I large lectures in the traditional format of two midterms and a final will be used. For Quarter II behavioral objectives will be available to the students, but in all other respects the strategy will be as

in the first quarter. During Quarter III the mastery learning PAS plan will be used. During Quarter IV the baseline data that have been gathered will be analyzed. During Quarters V and VI the video cassettes made at the average level will be used in the courses that will then operate in the traditional format. During Quarters VII and VIII the complete self-paced PAS strategy with live lectures and video cassette lectures will be offered. During Quarters IX and X the experimental IDEA system will be implemented and evaluated. Thus during the term of the project a total of six alternative conditions for large lecture instruction will be offered.

For each large lecture condition the following information about the students will be collected: course grade, gender, personality measurements such as anxiety and locus of control, ability measurement (ACT), high school science background, previous experience in open classroom, scores on study effort and attitudinal questionnaires, major academic interest, and other information such as minority status or age that might subset students. Using course grade and affective scores as the dependent variables, predictors will be sought among the independent variables. When correlations are found, a path analysis model will be used to assign relative weight to the variable's influence. Path analysis models for each condition will be compared for the evaluation. This basic model was used in the PAS evaluation previously discussed and allows counseling statements to be made to students who subsequently enter the courses.

Most of the information needed for the analysis is available from central university records or can be measured. Questionnaires will be developed by an evaluation team consisting of educators, psychologists, and scientists. Data processing will occur through the I.S.U. Test Scoring and Evaluation Service.

During the project the investigators hope to involve graduate students from psychology in this project. Research problems might include changes in attitude or personality measurements that occur during the enrollment period for any one student. Since the project involves the freshman year, students could be followed in a longitudinal study from one course to the next. These studies are not

proposed as a specific aspect of the evaluation plan but if carried out will be considered as part of the evaluation results.

Concluding Statement. This proposal has attempted to describe a solution to a specific problem in large group instruction. The problem is presented in local context, but it is global. I.S.U. has a past history of attempting solutions to educational problems and various university services are willing and able to focus their attention on the proposed solution. The funding of this project has mobilized these services and has implications far beyond the specific project.

If the project indicates that the total combination or component strategies are viable alternatives to mass live instruction, structural changes could occur in the university. On campus, other courses should be developed to offer these alternatives; yet it is simplistic to assume a complete change to any one alternative or that any one course will offer all alternatives. Off campus other changes may occur. Long-range planning at I.S.U. indicates that student populations will decline in the 1980's. The university is considering an open concept in which staff will travel through the state offering courses at designated centers. Media instruction in a self-paced format could have a place in this concept, and the results of the proposed study will be a significant factor in deciding what part media instruction will play.

ANALYSIS OF THE ELEMENTS OF A GRADE

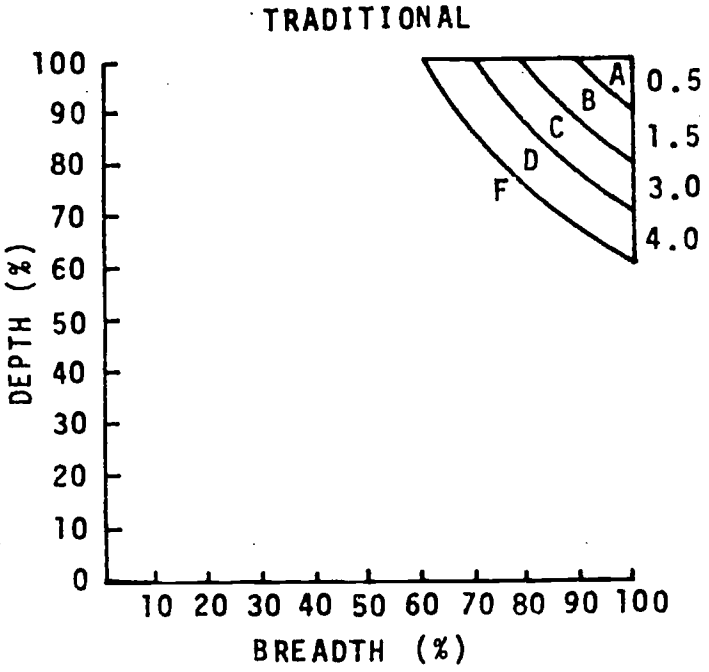


Fig. 1A

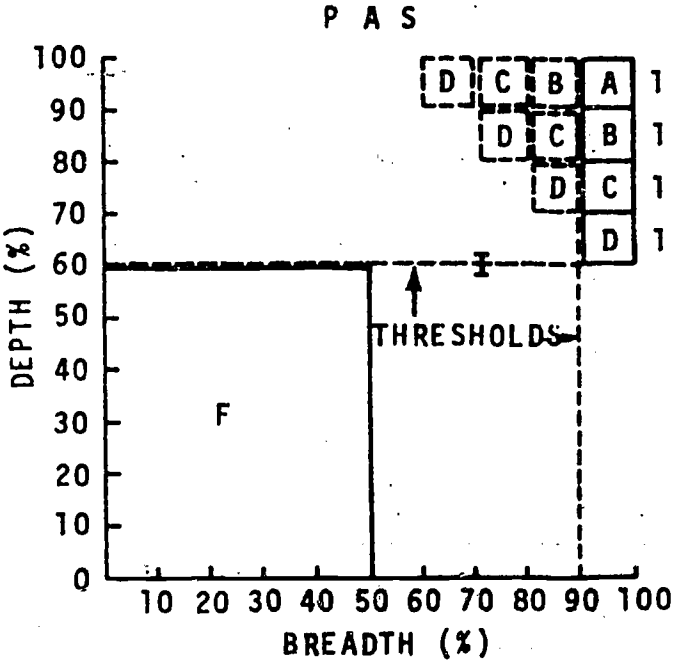
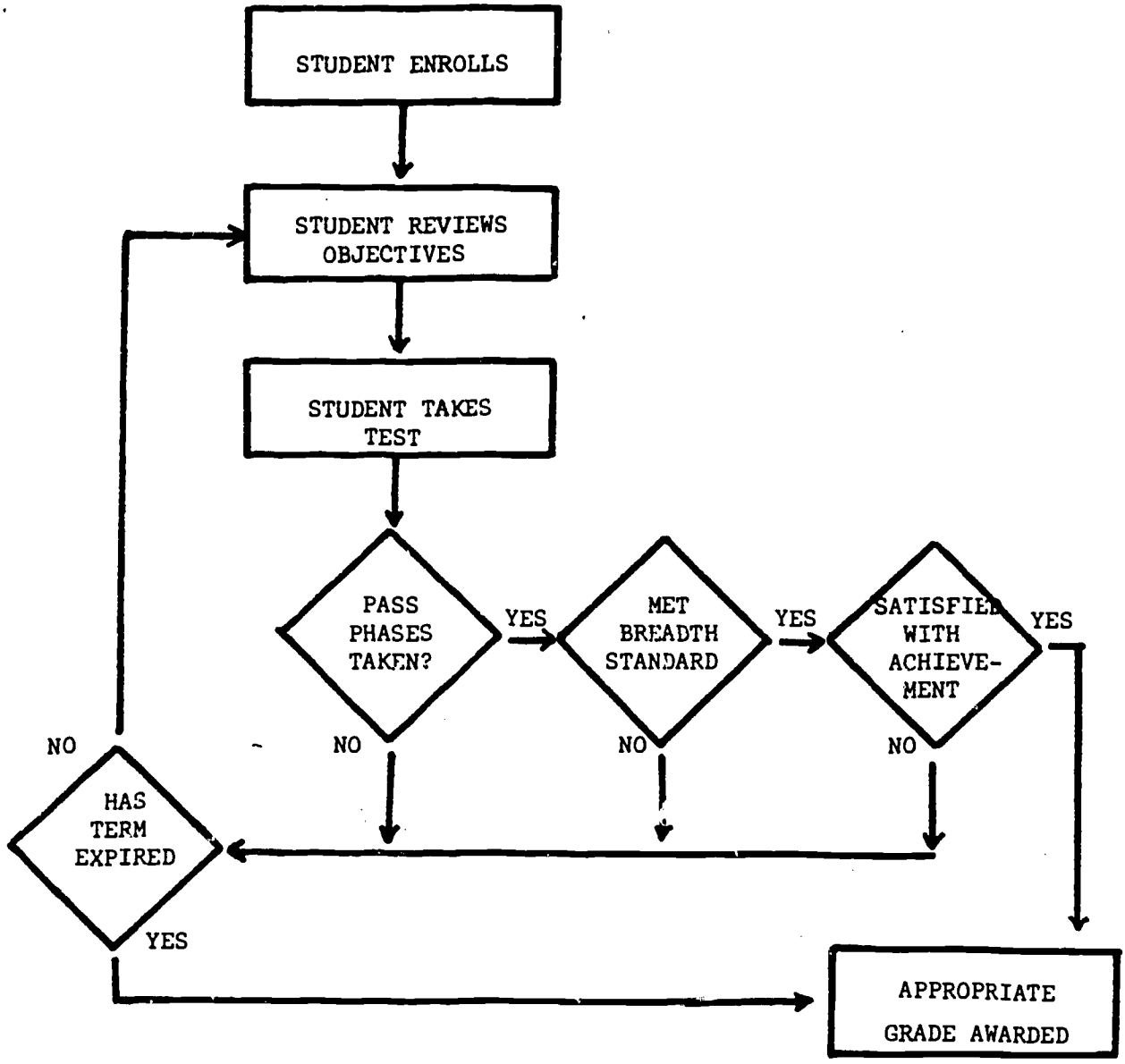


Fig. 1B

Fig. 1 Analysis of elements of a grade. Breadth is defined as curriculum (content) of course. Depth is defined as student's understanding in an area of the curriculum.

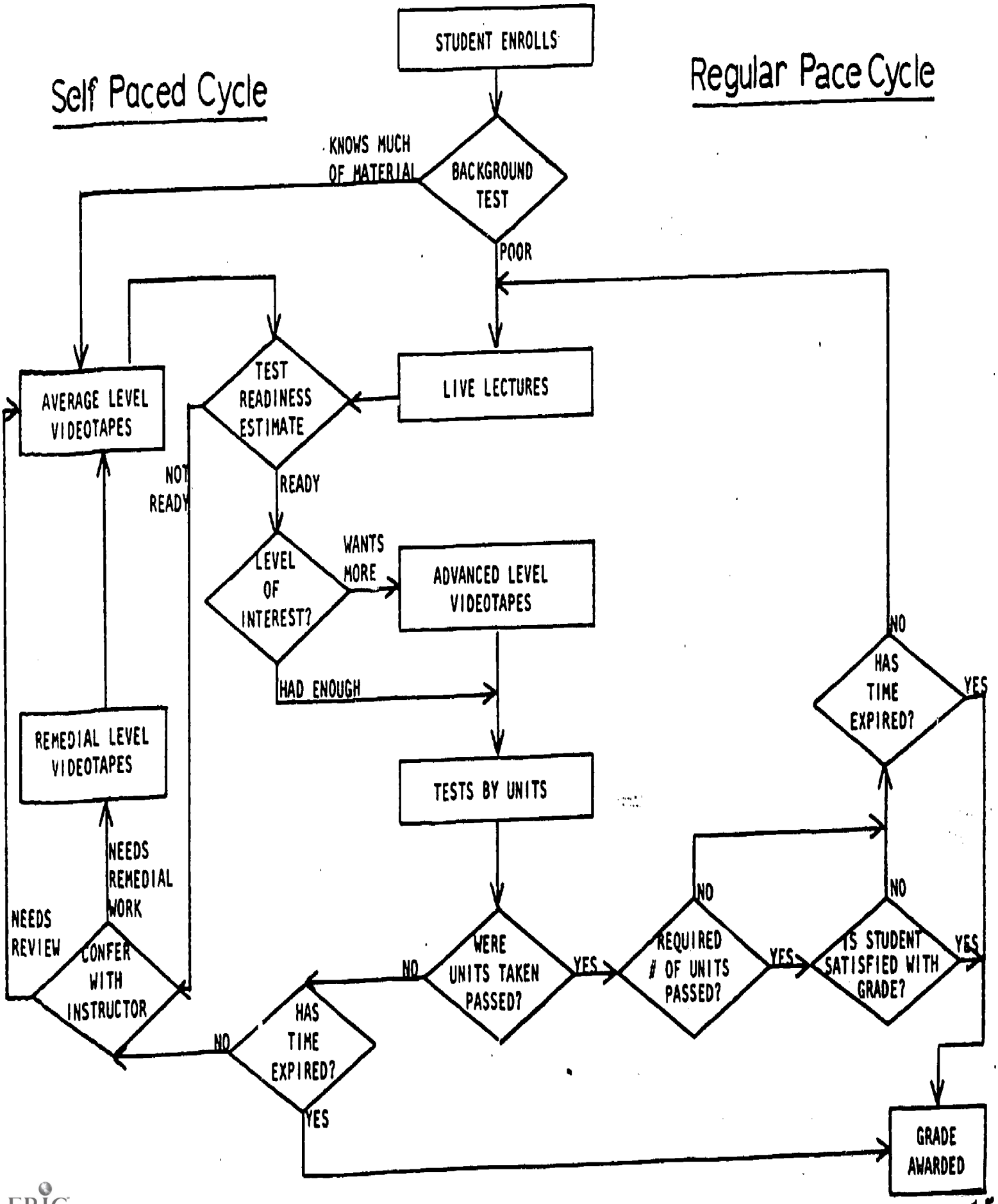
A. A linear plot of what a grade in a traditionally taught course represents in terms of depth and breadth of student understanding. If a 60% score is considered passing, then area of passing performance is outlined by figure in upper right. Letter grades are set up at 60%, 70%, 80%, 90%. Numbers to right of figure give relative areas of performance for each grade. (cf. to Fig. 2B).

B. A plot of the elements involved in a grade awarded under PAS. For simplicity, we have hypothetically assumed ten phases of which nine must be passed to earn a grade. A score of 60% has been set as "passing." PAS imposes a dual threshold on student. He must reach a certain level on a phase to pass that phase and he must pass nine phases to pass the course. Once these thresholds are exceeded his grade is determined by his depth performance alone. In this way, both the breadth and depth of a student earning a grade can be specified. Students not passing five out of ten phases fail. Students passing at least five but not nine phases receive an incomplete grade (I). Grades enclosed in dashed lines indicate alternative grading schemes that could be used if breadth control was not utilized i.e., passing 80% of the course with a 90% or greater average would equal B. This feature would allow the PAS grading scheme to approach the traditional (Fig. 2A). Numbers to the right of the figure indicate relative areas of performance for passing grades under PAS.



Flow chart of the pathways that students may follow in the Phase Achievement System.

Flow of Students Within Any One Course in Program



A3